

Order of Magnitude and Estimation

Syllabus statements

1.1.1-1.1.4

—due Wednesday, 9/14/11

Warm-up/Journal question:

- How many plain M&M's would it take to fill a beaker like the one on the front counter?
 - On your warm-up sheet:
 - Estimate your answer, and explain HOW you reached your estimation.**
 - Write estimated answers for each person in your group on your whiteboard (numbers ONLY...no names with them!)

Why do we need to estimate?

Estimated calculation--example

- NO CALCULATORS! Estimate the answer to the following:

$$\frac{(3728) \times (470165 \times 10^{-14})}{(278146) \times (0.000713 \times 10^{-5})} =$$

- Work with your group—come up with one answer that you write on your group whiteboard.

"Fermi Questions"

- What is the approximate circumference of the Earth?
 - Use what you know in order to estimate an answer!
 - NO calculators!



Image from:
<http://www.sciencetoday.org/Satellite/>
<http://www.nasa.gov/mission/main/story.html>

Fermi Question Assignment:

- As a group, do this on your whiteboard...
- Draw a Fermi Question out of the bowl.
- Estimate an answer to your question
- SHOW how you got your answer

Order of Magnitude (OM)

- Always written as a whole number power of ten (i.e. There are $\sim 10^6$ people living in the Seattle area)
 - The OM is the power of ten that is "closest" to the value you are estimating
- OM values are not very precise! They are an ESTIMATE!
- But they DO give us a general idea about the magnitude (size) of a number

Order of Magnitude (OM)

- For example, the world's population is on the order of how many people?
Approximately 10^{10} people.
- Hold it! How is that determined?
- Let's estimate that the population is somewhere between 6 and 7 billion people...

Order of Magnitude (OM)

- So to make it easy, let's say 6.5 billion, or 6.5×10^9 people.
- OM is based on a logarithmic function (since it is totally based on powers of 10, just like a log scale!)
- THAT MEANS: the reason we round UP to 10^{10} is *not* because the value would round up...we must look at the power of 10!

Calculating OM

- Step 1: $\log(\text{value}) = z$
- Step 2: round z to the nearest whole number
- Step 3: $OM = 10^z$

For our example:

- Step 1: $\log(6.5 \times 10^9) = z$
- Step 2: round z
- Step 3: $OM = 10^z$
